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THE LIFE-HISTORIES OF THE NEW YORK SLUG CATERPILLARS.—I.

PLATE VI, FIGS. 1–19.

By Harrison G. Dyar, A. M., Ph. D. and Miss Emily L. Morton.

Introductory.

The authors of the series of articles, of which this is the first, have long been interested in the species of Eucleidæ found in this country, especially in their larval state. We have concluded to present jointly a full account of the life-history of each species, as rapidly as we are able to work them out. The accounts of the habits are by Miss Morton, and the labor of obtaining fertile eggs has been performed by her. Dr. Dyar has prepared the technical descriptions.

The following is a preliminary synopsis of the different species known to occur in New York State, listed in ascending order. We are unable to make it final at present, for the reason that several of the forms are still imperfectly known, and there may be one or two more species than we now recognize. It will, however, serve to outline the scope of our work, but we shall not be able to present the descriptions consecutively. It is, perhaps, unnecessary to state that we would feel duly grateful to receive larvæ or cocoons of any of the less known species (marked with an asterisk below) or of any species not on this list.

Section 1. Spined larvæ.—Larvæ with spinose processes; the spiracle on joint 5 higher up than those on joints 6 to 12 and the tubercle above it missing.

Type 1. Three distinct tubercles on the last two thoracic segments. Subdorsal row on joints 4 to 13 converted into detachable, hairy, fleshy appendages.

Phobetron pithecium.

Type 2. Only two tubercles on the thoracic segments. Spines arising from fleshy horns more or less developed. Dorsal and lateral areas both broad.

Without patches of long, detachable skin spines between the terminal horns

Horns short, the purple dorsal band without black lines.
Adoneta spinuloides.
Horns partly long, the bluish dorsal band four times lined with black.
Euclea indetermina.
With one pair of spine patches. The red subdorsal band entire or broken by marks concolorous with the side lines.....**Euclea pænulata.**
With two pairs of spine patches.
Horns short; the red or yellow subdorsal band conspicuously broken by quadrate discolorous patches.....**Euclea delphinii.**
Horns partly long, partly obsolete. A green dorsal "blanket" with central purple patch.....**Sibine stimulea.**

Type 3. As in type 2, but the pair of horns of joint 13 consolidated into a pointed tail. Tubercles and spines much reduced, obsolescent.....**Parasa chloris.**

Type 4. Dorsal space contracted, larva much flattened. Horns tapering, flattened, projecting laterally, fringed by the slender spines. Green with few red dots between the yellow subdorsal lines.....**Sisyrosea inornata.**

SECTION 2. Smooth larvæ. Without any spinose horns or processes. Tubercles obsolete or obscurely setiferous. Spiracles in line; all the tubercles represented.

Type 5. Dorsal and lateral spaces both broad, subventral space narrow. Last segment rounded quadrate. Color green.
Without dorsal red marks.
Yellow subdorsal line bordered above by a dark shade.
Apoda y-inversa.
"Similar" to the preceding.....* **Apoda biguttata.**
No bordering shade to the subdors alline.....**Tortricidia fasciola.**
With dorsal red marks.
A large, blurred, red cross covering the back....***Tortricidia flavula.**
A small, red cross in the middle of the back..*(?)**Tortricidia testacea.**
A tiny red dorsal dot centrally and series of red dots near anterior end or a continuous red band.....*(?)**Heterogenea flexuosa.**

Type 6. As in type 5, but the body ends with a pointed tail.
Whitish green with straight subdorsal line.....*** Packardia geminata.**
Yellowish green with wavy subdorsal line.....*** Packardia elegans.**

Type 7. Lateral space obsolete, dorsal and subventral spaces broad. Green with variable brown patches. Body ends in a pointed tail..**Eulimacodes scapha.**

NORTH AMERICAN EUCLEIDÆ.

NOMENCLATURE.

We have adopted the name Eucleidæ for this family in preference to those formerly in use, since we consider it proper that the family name should be taken from a genus which is not a synonym, and under this restriction the rule of priority applied. We have, therefore, discarded the names Limacodidæ and Cochlidiidæ, since the genera *Limacodes* and *Cochlidion*, on which they were founded, have been relegated to

the synonymy. The name Eucleidæ was proposed in the works of Messrs. Neumoegen and Dyar and of Professor J. H. Comstock. The term Apodidæ of Mr. Grote (Syst. Lep. Hild. 1895) is synonymous as is also the term Heterogeneidæ of Mr. Meyrick (Handb. Brit. Lep. 1895.)

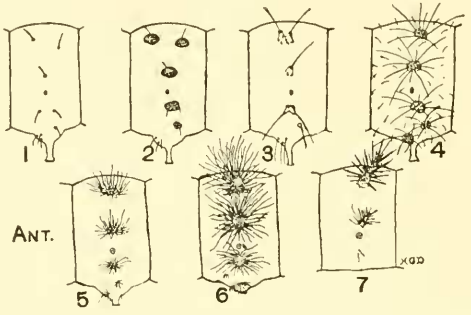
General Characters.

Eggs. The eggs of the several species of Eucleidæ do not offer specific differences, as a rule. The shell is very thin, skin-like, not distinctly ornamented. The egg is elliptical in outline and greatly flattened, so much so as scarcely to present a measurable thickness (to the naked eye), at least when freshly laid. They are deposited singly or in groups, in the latter case overlapping like the shingles on a roof. This type of egg is found in other groups of the Microlepidoptera, and refers the Eucleidæ to this superfamily.

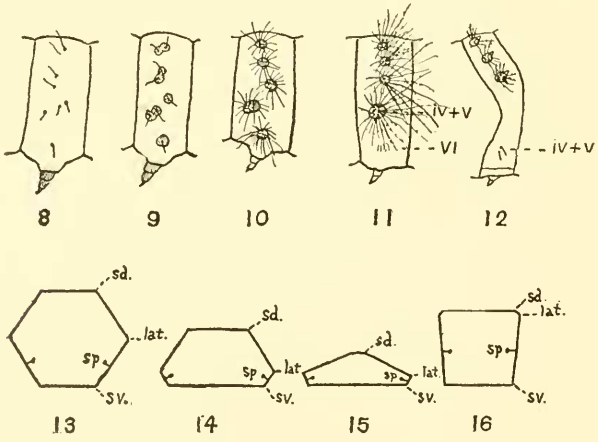
Larva. The head is modified from the type usual in Lepidoptera in lacking in all that portion of the corneous case above the clypeus the usual hard character. It is withdrawn under joint 2, which folds over it like a hood. Joint 2 is more or less completely withdrawn under joint 3, and is usually unornamented, so that the first segment completely visible from above, and the one on which the various markings commence is joint 3 (the mesothoracic segment). The prothoracic shield is present, but more or less rudimentary and always functionless. The segments are of the usual number, thirteen, the last one small and not showing its compound nature by a constriction, as is often the case in the lower Microlepidoptera. All the segments are closely united, the separating incisures often very obscure and difficult to distinguish. The body is flattened by the reduction of the feet and subventral area; in general outline elliptical, the dorsum arching more or less, as the height is considerable or the reverse. The thoracic feet are very small, the abdominal ones wanting, the whole ventral region being flexible and adapted for locomotion. Dr. Chapman states (Trans. Ent. Soc. Lond. 1894, p. 345) that there are suckers on the first eight abdominal segments, though the first and last of these are poorly developed; these suckers are probably homologous with prolegs.

The abdominal tubercles are derived from the highest Microlepidopterous type. Primitive tubercles i and ii consolidated, iii single, iv and v consolidated, all converted into many haired warts, thus giving three segmentary rows of setiferous warts, subdorsal, lateral and subventral. By the reduction of the subventral area, the third row of

warts is obsolete, represented in the Eucleidæ by a few weak setae. The other two rows are functional and compose the armature of the several species. The evolution is illustrated in the accompanying cut



(figs. 1 to 7), which shows a series of segments advancing from the most generalized type up to *Sibine stimulea*. The thoracic warts are also derived from the Microlepidopterous type; but are more modified. In this type there are five warts formed from the primary and subprimary tubercles i*a*+i*b*, ii*a*+ii*b*, iii, iv+v and vi as shown in figures 9 (*Simæthis pariana*) and 10 (*Ino prunî*). In the Megalopygidæ (fig. 11) a reduction has been effected in the lower row as on the abdomen (fig. 6). In the Eucleidæ, one more row is rudimentary on both thorax and abdo-



men and the rudimentary subventral row of the Megalopygidæ is lost. Therefore there remain three well developed thoracic tubercles (see the figures of *A. y-inversa* Plate VI, fig. 8). These are all present in the

series of species with reduced tubercles and in the lowest of the spined Eucleids (*Phobetron*, fig. 12); but in the higher spined forms, the middle row disappears, precisely as it has disappeared on joint 4 of *Megalopyge*, probably in response to a similar need. In all the spined Eucleids, there is also a reduction in the number of warts on the first abdominal segment, which will be specially described under *Sibine stimulea*.

Along the three abdominal rows of tubercles, and correspondingly on the thorax, the body is more or less ridged. We shall call these the subdorsal, lateral and subventral ridges respectively. Owing to them a section of the body of a Eucleid larva forms a hexagon instead of a circle, as in most other Lepidoptera. This may be regarded as the fundamental type (fig. 13), though it nowhere actually exists that we know of. Usually the space between the lateral and subventral ridges is contracted, giving the form shown in fig. 14. In *Sisyrosea* the uppermost space is also contracted, giving the form of fig. 15, the flattest Eucleid larva known to us. In *Eulimacodes*, a quite different process has taken place. Instead of the lower side-area being contracted, the upper side-area is reduced nearly to obliteration, and we get the outline of fig. 16, a square.

The surface of the body is divided by these ridges into three areas. We shall name them as follows:

The unpaired dorsal space between the two subdorsal ridges we shall call the dorsal space. The space on each side between the subdorsal and lateral ridges, the lateral space. The space between the lateral ridge and the lower edge of the body, which contains the spiracles, the subventral space.

The surface of the skin is not smooth in the later larval stages, but is sunken in certain more or less well defined areas. These areas have a flat bottom and more or less perpendicular sides and appear to be possible in these larvæ on account of the unusually thick skin. They have the following definite arrangement, though they may be imperfectly developed or even partly absent, as we shall describe in individual species: In dorsal space (1) a median row of large depressions, intersegmental, we shall call the dorsal row; (2) a paired row just above the subdorsal ridge; segmental, and therefore alternating with the dorsal, we call the addorsal depressions. In the lateral space (3) a segmental row of small depressions just under the subdorsal ridge, the upper lateral segmental, (4) a large intersegmental row in the middle of the lateral space, the lateral depressions, two rows closely

alternating and nearly in line (5) one segmental, (6) the other intersegmental, just above the lateral ridge, we shall call the lower segmental and lower intersegmental lateral respectively. In the subventral space, two intersegmental rows one above the other, the lower a little the most posterior, will be called (7) the upper subventral and (8) lower subventral; finally between the latter may be developed (9) a small segmentary row just above the ventral edge; and the smallest depressions of all, only rarely seen, are (10) the stigmatal row, situated segmentarily above and before the spiracles. Each of these depressions contains one or more glandular centers which appear as small rounded patches. They are more primitive than the areas themselves,* and may appear when the latter are scarcely distinguishable. The dorsal depressions correspond to four glandular centers, a paired row on the anterior and posterior edge of each segment, consolidated intersegmentally; the other depressions seem to have but one center. †

The setæ on the warts vary greatly, but are only rarely primitive setæ. They will be specially described. The skin surface is covered with minute points, which usually are converted into clear granules. These also come under the series of special characters. In general the depressed areas are smoother than the elevated portions of the surface.

Cocoon.—The cocoon is composed entirely of the secretion of the spinning organ. It is closely woven and forms a hard, compact, though thin layer like stiff cardboard. It is so constructed that one end opens in the form of a circular lid at slight pressure. This structure is similar to that of the Megalopygidæ, but is an improvement on it, being more compact, definitely rounded and smooth. The lid is not visible in the intact cocoon, as in the case of the lower family just mentioned. The shape is rounded or elliptical and colored some shade of brown.

*The largest of these glandular spots, namely the dorsal (1) and the lateral (4) may be distinguished in the Megalopygidæ and even in the Pyromorphidæ. In *Harrisina coracina*, which is before us, there are evidently present a series of paired intersegmental grandular dots and a larger lateral row, showing as whitish patches against the purplish markings. Thus the principal structural characters of the Eucleidae, including the arrangement of the tubucles and their modification to bear spines, the depressed areas, as well as the body shape, the retraction of the head and even the peculiar modification of the abdominal feet are all foreshadowed in the two families mentioned. Even the dislocation of the spiracle on joint 5 can be observed in *Harrisina*, though the wart above it is normal. According to the view here adopted these families are close to the ancestral forms of the Eucleidae, leading up from a Tineid-like progenitor.

† We shall illustrate the dorsal and lateral depressed spaces in the plate for *Tortricidia pallida*, the subventral ones under *Eulimacodes scapha*.

Pupa.—This is characterized as follows by Dr. Chapman: Belongs to the Incompletæ. Less solid and rounded than in the Obtectæ, appendages partially free. Free segments extend upward to the third abdominal; 7th free in the male, fixed in the female. Dehiscence accompanied by freeing of segments and appendages previously fixed; pupa progresses and emerges from cocoon. (Trans. Ent. Soc. Lond. 1893, p. 118.)

Moth.—We shall not treat of the structure or relations of the moth in this series of articles. For the position adopted see Comstock (Wilder Quart. Cent. Book p. 104) Chapman (l. c.) and Dyar (Trans. N. Y. Acad. Sci., vol. XIV, p 54).

Apoda y-inversa *Packard.*

1864—*Limacodes y-inversa* Packard, Proc. Ent. Soc. Phil. Vol. III, p. 341.
1882—*Limacodes y-inversa* Grote, New Check List, p. 17.
1886—*Limacodes parallela* Hy. Edwards, Ent. Amer. Vol. II, p. 10.
1891—*Limacodes y-inversa* Smith, List Lep. p. 28.
1892—*Apoda y-inversa* Kirby, Syn. Cat. Lep. Het. Vol. I, p. 553.
1894—*Apoda y-inversa* Neumoegen & Dyar, Jour. N. Y. Ent. Soc. Vol. II, p. 74.

Larva.

1894—*Apoda y-inversa* Dyar, Ann. N. Y. Acad. Sci. Vol. VIII, p. 221 (mature larva).

Special Structural Characters.

Dorsal space broad, narrowing slightly toward the extremities, ending behind in the broadly quadrate joint 13, not strongly arched. Lateral space broad, oblique, scarcely concave, narrowing a little toward the extremities. Subventral space very small, contracted. Subdorsal ridge at first prominent, later smooth, consisting of the rounded angular change in direction of slope between back and sides. Lateral and subventral ridges moderately prominent, approximate, the lateral at first tubercular, later smooth. Ancestral warts reduced; in stage I the subdorsal setæ ia + ib on joint 4 and i + ii on 5–12 are represented by single spines with a slight central process, which lean in alternating directions on successive segments (Pl. VI, fig. 1); later the warts are represented by tubercles bearing two setæ on subdorsal, one on lateral ridge (Pl. VI, fig. 8); in the last stage obliterated, the rudimentary setæ persisting. Subventral setæ rudimentary. Depressed areas well developed, though not extraordinarily so, rather small, rounded, slightly sunken, not very sharply defined, smooth. The series numbered 1 to 8, inclusive, may be distinguished. Skin at first smooth, later covered with short secondary spines, and finally with closely-crowded, round, clear

granules of somewhat unequal size. After the last molt the specific coloration characters definitely appear, and the setæ are nearly obliterated.

The coloration is uniform green with certain yellow lines, evidently adapted to escape observation.

The larva is a typical Eucleid, not highly specialized, yet without any very generalized characters. The peculiar structure and arrangement of the subdorsal setæ in stage I cannot be congenital in our view,* but may be some special adaptation to this stage, in which the larva does not feed. Later the primitive tubercles appear as reduced and finally rudimentary structures. The spiracles are in line, normal. The depressed areas, characteristic of the family, are in a state of moderate development, while the skin granulation is also intermediete between such extremes as *Sibine* and *Eulimacodes*.

AFFINITIES, HABITS, ETC.

This species is related to the European *Apoda avellana* (*Limacodes testudo*) in a close degree. The larvæ seem not to differ, to judge by Dr. Chapman's description and by a well prepared specimen from Staudinger and Haas. The moths only differ in that *y-inversa* is usually less suffused with brown, while *avellana* is rather smaller, more like our *A. rectilinea*.

We may regard this species as derived from a former circumpolar fauna, whose near allies are not now found in tropical South America,

*These structures appear in *Tortricidia fasciola*, stage I (Packard, Proc. Amer. Phil. Soc., xxxi, pl. ii, figs. 15–16) and in *Apoda avellana* (Chapman, Trans. Ent. Soc. Lond. 1894, pl. vii, figs. 16–18.) Dr. Chapman remarks (l. c., p. 345) "When the larva has completed its development within the egg shell . . . it is free from any spines or processes, but at the period of hatching, certain long spines are rapidly developed." We cannot endorse Dr. Chapman's view that these spines do not correspond to the tubercles. They seem to us to correspond to the warts of subdorsal row, and their apparent alternation, in our species at least, is due to the angle at which they arise from the body, rather than to a dislocation of their bases. In *Tortricidia pallida* (which we hope to reach in due course) these spines of stage I are in a still more interesting condition, being Y-shaped, and thus intermediate between the single knobbed spine of *Apoda* and the three-pronged one of *Adoneta*. (Packard, l. c. p. ii, fig. 8.) It should be remembered that the spined Eucleids are more generalized than the smooth ones, and we should not look for the most generalized condition of stage I in *Apoda* and allies, but in *Adoneta* and *Sibine*. In the latter there are three setæ from each wart, and no sign of alternation on successive segments, thus quite agreeing with our view, but not supporting Dr. Chapman's inference that the primitive arrangement corresponded to that of *Eriocephala*. (l. c., pp. 345–347.)

as we will show to be the case with *Sibine* and *Eulimacodes*, but in the northern temperate regions of both the old and new worlds.

The larvæ of the nearest American allies of *A. y-inversa* (*A. rectilinea* and *A. biguttata**) are unknown. It differs as follows from *Tortricidia fasciola*, which is the only larva at present known at all resembling it: More elongate, less shortly rounded than *fasciola;* sides less concave, the tail the same. Color much less transparent, not the clear yellowish green, but whitish, opaque. Depressed spots blurred in the whitish ground, not indicated by broad pale yellow rings. Setæ obsolete in both, but the skin of *fasciola* is more coarsely and irregularly granular, the incisures marked, cleft-like, while they are obscure in *y-inversa*. The subdorsal line is distinctly bordered above by a dark shade, whereas in *fasciola* there is no other color than the yellowish green and yellow.

The eggs are laid singly, and the larvæ after hatching eat only the parenchyma of the leaf for the first two feeding stages. The manner of feeding is characteristic of the species. *Y-inversa* feeds in a track on the upper side of the leaflet the width of its body. (Plate VI. fig. 19, stage II; fig. 13, stage III.). In the fourth stage and after it eats the whole leaf (Plate VI. fig. 16, 17). At New Windsor, the larva has been found only on the species of hickory; it has occurred on hickory in Van Cortlandt Park, New York City, and near Glendale, L. I.; Dr. Thaxter also reports it on this food-plant. The larva described by Mr. Dyar was found on oak, but the identification is not positive as *y-inversa*.

The larva of *y-inversa* seems to be not commonly found. At New Windsor a few are occasionally taken in the bags placed on the growing trees for the confinement of other hickory feeding larvæ. Near New York City the larvæ occur mostly on low hickory shrubs, always singly. They are subject to the attacks of a number of parasites in consequence of which their numbers are greatly diminished.

There is but a single brood during the year. The moths (Plate VI, fig. 9) fly during the first half of July. The males seek their mates soon after dark, between half-past eight and nine o'clock, flying with unerring instinct directly to that part of the cage where the female is clinging. After pairing the moths remain *in coitu* until about the same time the next evening. The females immediately after begin to lay their eggs, and continue night after night until all are laid.

The mature larvæ may be found early in September, making a period of about two months to complete the seven larval stages.

* We believe the identification of this larva by Dr. Packard (5th Report, U. S. Ent. Com. p. 147) to be founded upon error.

CRITICISM OF PREVIOUS DESCRIPTIONS.

The only notice of this larva, besides the mention of the food plant by Dr. Thaxter (Can. Ent. XXIII, 34), is the one by Mr. Dyar, referred to above. This differs from the larvæ before us in that no mention is made of the yellow line on the anterior portion of joint 3. As the determination was not made positively, it is possible that Mr. Dyar may have had the larva of *A. biguttata* before him. In a letter written in 1891, is the following from Dr. Thaxter: The larvæ of "both the *Limacodes* you mention (*biguttata* and *y-inversa*) are very much alike, green or slightly yellowish, slightly dome-shaped with slight longitudinal ridges and certain lighter dorsal markings. . . . . Quite different from *scapha*."

DESCRIPTION OF THE SEVERAL STAGES IN DETAIL.

Egg.—With the characters of the family. Reticulations obscure, linear, rounded, scarcely angular, yet not separated into isolated areas, not characteristic. Elliptical, 1.6x1.2 mm. Laid singly in nature. Of the usual yellow color.

Stage I.—Head entirely brownish black, enclosed in joint 2; width .3 mm. (calculated .28 mm.). Rounded elliptical, the subdorsal and lateral ridges prominent, consisting of segmentary tubercular elevations, causing the dorsal area to form a furrow, and the lateral to be concave; ends square, subtruncate. Skin perfectly smooth, no granules of any kind. Primitive tubercles i+ii represented by a series of large, segmentary spines, double on joints 3 and 13, single, but with a small knob-like projection about the middle on the other segments. (Pl. VI, fig. 2.) On the abdomen these spines alternately lean in and out, but their bases are not transposed. They can be traced deep into the skin. Row on the lateral ridge (iii) similar, but shorter and without projections; in line. (Pl. VI, fig. 1.) Color whitish, dorsal space faintly greenish by transparency, subdorsal ridge whitish the spines dark. Length 1.5 mm.

Stage II.—Head green; width .4 mm. (calculated .39 mm.). Shape as before (Pl. VI, fig. 6, for outline). Lateral ridge not reaching beyond the subventral one, which bears two setæ on each segment. Skin covered sparsely with small, clear granules which bear short spines; also some spines from the tubercles of subdorsal row, which consist of two setæ the whole length of the ridge; lateral tubercles with one long and many short setæ. The setæ differ from Stage I in being

double throughout the subdorsal ridge, the primary setæ pointed, some of the secondary a little swollen at tip. Lateral ridge bears three setæ on joints 3 and 4 and a long, slender one on joint 13, its tubercle scarcely larger than the secondary ones. Dorsal and ad-dorsal depressions ill-defined, smooth, the tubercles on the rounded latticed ridges; a single row of lateral impressed areas, the spinose tubercles mostly above them; subventral region finely granular, not setiferous. Color green, a broken whitish stripe along the subdorsal ridge. Length 1.5 to 2 mm.

Stage III.—Width of head .5 mm. (calculated .54 mm.). Shape as before, the dorsum depressed between the prominent subdorsal ridges; lateral ridge also prominent, composed mostly of the large tubercles. Dorsal depressed areas well defined, the colorless tubercles with short secondary setæ on the latticed ridges; the lateral areas defined as far as the central and upper rows, the lower double row not distinguished. Lateral latticed ridges quite well-defined, but rounded, not sharp like the dorsal ones. Secondary tubercles sparse. Primary tubercles large, conical, with two setæ on subdorsal and one on lateral as before. Fine setæ are present on joint 2, four in the region of the cervical shield, one before the spiracle. Color green with a pale yellow subdorsal line below the skin. Length 2 to 3 mm.

Stage IV.—Width of the head .75 mm. Elliptical, rounded at both ends, evenly arched, highest about the middle; ridges moderately rounded, the subdorsal with two long, coarse setæ, the tubercles low, most of the secondary setæ reduced to skin spines, but a few still distinct bristles. Lateral ridge with single large seta and many small ones as before. Dorsal space with sparse clear granules, scarcely setiferous, but spined. The dorsal impressed spaces show as white intersegmental spots, the ad-dorsal as circular hollows; smooth, not discolored. A yellowish white row of spots, alternating with the tubercles. Lateral space rather coarsely granular, the depressed areas smoother, ill-defined, not discolored. Subventral area only sparsely granular, the intersegmental hollows elliptical longitudinally. Length 3 to 4.2 mm.

Stage V.—(Pl. VI, fig. 18, side view; fig. 6, front view; fig. 3, lateral tubercle, figs. 16–18, life size.) Width of head 1 mm. (calculated 1.04 mm.). Elliptical, the posterior end quadrate, evenly arched. Subdorsal and lateral ridges made prominent by segmentary, high, conical tubercles. Green; a distinct yellow line under the subdorsal ridge, slightly waved, not reaching the anterior edge of joint 3, which is yellow to the lateral area. Spines dark. Skin with sparse clear

granules, becoming short clear spines on the ridges, but in small number (Pl. VI, fig. 3). Impressed spots not large, well-defined and smooth, not very deep; the dorsal as before; lateral ones all present, of the two rows above the lateral ridge (Nos. 5 and 6), the segmental are a little higher up than the intersegmental, both small. The two subventral rows small, rounded, the lower a little anterior to the upper, not at all confluent. The color is a leaf green, like the under side of a hickory leaf, neither very yellowish nor whitish. The tubercles seem smaller than in the previous stage, the setæ more slender and less conspicuous. Toward the end of the stage the yellow lines become very distinct, the subdorsal bordered above narrowly, and mainly in the hollows of the undulations with dark clear green. Impressed spaces all yellowish. Length 4.2 to 7 mm.

Stage VI.—Head green, eyes black, jaws brown; width 1.4 mm. (calculated 1.44 mm.). Smooth, rounded, no tubercles on the ridges (Pl. VI, fig. 4 for front view), lateral outline low arched, highest a little before the middle. Setæ black, pointed, two on subdorsal ridge, one on lateral ridge. Color soft green, much as before, a yellow line anteriorly on joint 3, broad and distinct, joining a white line along the subventral edge. A yellow line along the subdorsal ridge, from the middle of joint 3 to the end of the broad tail, incised by the addorsal depressions, the scallops filled in with dark green. All of the dorsal, and two of the lateral (4 and 5) impressed spots pale yellow. A row of intersegmental yellow spots below skin along lateral ridge. Skin closely covered with conical granules, many quite sharp pointed. Dorsal depressed spaces small, smooth, moderately deep; lateral ones obscure, hardly defined. Length 6.5 to 10 mm. Differs from Stage V in having the ridges smooth, except for the short setæ, rounded angular, not elevated.

Stage VII.—(Pl. VI, fig. 5, front view; fig. 10, side view; fig. 11, back view, all×2; figs. 14, 15, natural size.) Width of the head 2 mm. Very smooth, setæ fine, slender and short, entirely inconspicuous, not long and distinct as before. The setæ representing tubercles iv+v along the subventral edge are distinct in comparison with the greatly reduced ones on the subdorsal and lateral ridges. Body quite smooth, no ridges; dorsal space flat, moderately broad; lateral space sloping, not concave; subventral space small, retracted. Lateral ridge slightly waved. Subdorsal line broad and distinct, yellow with dark bordering spots above, the two lines joining on the quadrate tail. Yellow line on joint 3 anteriorly as before. Impressed spots yellowish, body light green. Skin closely covered with large, clear granules,

closely appressed and somewhat irregular (Pl. VI, fig. 7). Impressed spots small, rather deep, the bottom with a transverse groove in the dorsal plates, the rest finely granular; upper and lower segmental lateral spaces not discolored, the latter obscure. A row of small yellow dots beneath he skin of lateral ridge.

Five days after the molt the color is a bright, rather yellowish green with a slight whitish cast. The dark border to the subdorsal line appears continuous to the naked eye.

Six days.—Becoming whiter, like *Packardia geminata*. The lateral ridge is green, but the rest is rather opaque whitish green. Subdorsal line very distinct, pale yellow, spotted with an orange tint intersegmentally, edged above continuously with blackish green, widest segmentally. Yellow line on joint 3 anteriorly not orange shaded, fading into the white subventral line. Depressed spaces marked by faint yellow rings, as the glandular centers are green.

Seven days.—Still whiter. A fine whitish green, shading more translucent down the sides. On the tenth day the larva shrunk up, turned of a pale whitish and lost its hold on the leaf; the next day it had spun its cocoon. Length 9.3 to 15 mm.

Cocoon.—(Pl. VI, fig. 12.) With the characters of the group.

EXPLANATION OF PLATE VI.

(*Apoda y-inversa.*)

1. Stage I, side view, showing the arrangement of the setæ: enlarged.
2. One of the subdorsal abdominal setæ (after Chapman).
3. A tubercle of the lateral row, stage V, showing skin spines × 175.
4. Front view, stage VI.
5. Front view, stage VII.
6. Front view, stage V.
7. A seta of lateral row (same view as fig. 3) in last stage, showing skin granules × 175.
8. Side view, stage V, showing arrangement of setæ.
9. *Apoda y-inversa*, female.
10. Last stage, side view, showing the areas of the body.
11. The same, dorsal view.
12. Cocoon, on a leaf of *Carya alba*.
13. Feeding marks of the larva, stage III.
14. Mature larva, side view.
15. Mature larva, dorsal view.
16, 17. Larva in stage V.
18. The same, side view.
19. Feeding marks of the larva, stage II.

(Figures 9, 12 to 19 by Miss Morton; figures 1 to 8, 10 and 11 by Dr. Dyar.)

[Note.—The plate has been too greatly reduced so that 8 per cent. should be added to the dimensions of the figures to make the above measurements apply exactly.]